Conservation of Energy and Momentum

Procedures:
Open the Energy Skate Park simulation at http://www.colorado.edu/physics/phet. Resize the windows by dragging the edges. Play with the simulation for a few minutes: adding track, resetting the skater when he falls off the track, resetting the track, etc. Then answer the questions below.

Questions:

1. Reset the track to its original position by hitting the top "Reset" button. Hit "Live" to start the skater.
    a) Does the skater hit the same height on the opposite sides of the track? (Use the "pause" button and the measuring tape to help you determine this!)

    b) At the top of the track, what is the difference in the skater's potential energy relative to the bottom of the track if his mass is 70 kg?

    c) What is the skater's kinetic energy at the bottom of the track?

    d) Can you figure out where the simulation has set the skater's potential energy as zero?

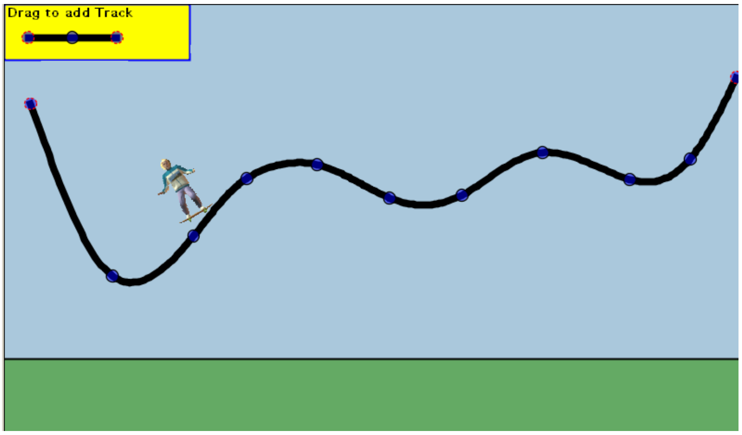
2. Explain in one paragraph how you could use your knowledge of energy conservation to plan a track that is fun, challenging, and safe. You might think, for example, when does he: fly off an end, slow down, make a hill, or land a jump?

3. Build a good track (one where the skater doesn't biff) and sketch it on your paper. Then turn on the energy Pie Chart, Energy vs. Position Graph, and Bar Graph. (You may need to move things around a little to see everything.)
    a) On all three visual aids, what color represents potential energy and which is kinetic energy?

    b) Describe how the bar graph changes as the skater moves along the track (i.e. what happens when the skater is high on the track? Low on the track?).

c) Sketch a few pie graphs and the corresponding bar graph on your drawing of the skater at various places along your track.

d) Explain which visual aid (the pie, energy vs. position, or bar graph) helps *you* understand conservation of energy better, and why.



Open Masses and Springs to do the following:

1. By investigation, determine when the Elastic Potential Energy is zero. Make sure you test your idea with several masses, all three springs and vary the stiffness of spring three. Write down how you determined the zero location(s) and explain why the position for zero makes sense.

2. Why did I have you use varying conditions?

3. By investigation, determine when the Kinetic Energy is zero. Make sure you vary the conditions for your experiment. Write down how you determined the zero location(s) and explain why the position for zero makes sense. *Simulation hint: The KE will not be calculated when you are moving the cylinder with the mouse*

4. Put a mass on a spring and observe the total energy graph as it oscillates. Pay attention to details of the energy distribution. Talk about why the energy is distributed differently for several situations. For example: When is kinetic energy at a maximum? What makes the elastic energy increase? Test your ideas with varying conditions. You will need some notes on your observations to complete step 5.

5. Each person should write a paragraph individually about the observations you made in step 4 about energy distribution. Be sure to include explanations of the observations.

6. Exchange papers with someone from another group. Read the paragraph given to you and make some critical notes; include both "positive" and "needs work" criticism. When you return the papers, reflect on the comments and talk about how you will improve your experiments and writing.

7. Set a mass on a spring and pause it when all three energies are measurable.
   a. Explain how you would show that energy is conserved using centimeters as an energy unit. Show a sample calculation and make a data table to organize your results. Repeat with at least 4 trials.

   b. In what units is energy usually measured?

   c. Why is it acceptable to use centimeters?

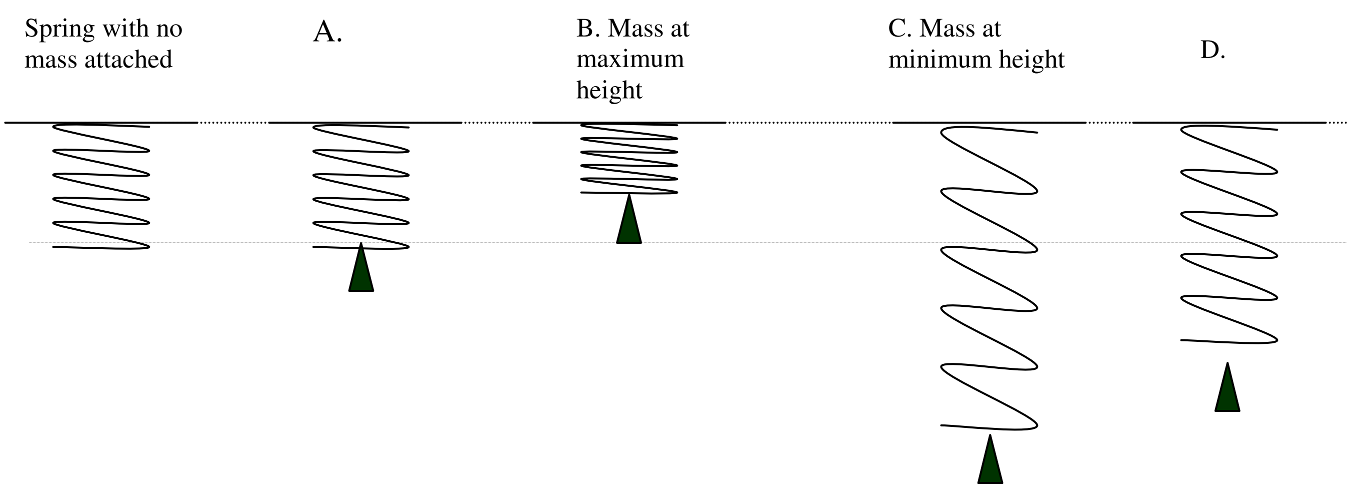
8. Suppose you have a skater going back and forth on a ramp like this. How does his energy distribution as he rides compare and contrast to that of the mass moving on a spring? You can run the *Conservation of Energy* simulation to test your ideas.

9. Build a good track and sketch it. Then use the Chart and Plot features to study the Skater's energy.
   - Decide which feature best helps you understand what makes your track successful.
   - Look in your text to find out what the Conservation of Mechanical Energy means and explain it in your own words.
   - Explain why your track is successful in terms of Conservation of Mechanical Energy. Include drawings of the Chart or Plot to help explain your reasoning.

10. Using the Law of Conservation of Mechanical Energy, explain what things need to be considered when designing any successful track.

11. An object is raised above the ground gaining a certain amount of gravitational potential energy. If the same object is raised twice as high, it gains
    a. four times the potential energy
    b. twice the potential energy
    c. there is no change in potential energy.

Use the figures below to answer 5-7. A spring is hanging from a fixed wire as in the first picture on the left. Then a mass is hung on the spring and allowed to oscillate freely (with no friction present). Answers A-D show different positions of the mass as it was oscillating. The dotted lines are on the drawing to help you see the change in position relative to the spring with no mass.



Select <u>all</u> the letters that apply.

12. Where does the spring have maximum elastic potential energy?

Revisit conservation of momentum on the next page.

1. Move the ruler beside spring #3. Align the 0-cm mark with the dotted line.
2. Place the weights below on the end of spring #3 and fill in the data table below.

Mass (g)	Mass (kg)	Force - weight (N) Hint: mass (kg) x gravity = weight	Distance spring stretched (cm)
50	0.050	0.050 x 10 = 0.5	
100			
250			

3. Using Hooke's Law (Force = elasticity x distance) calculate the elasticity of spring #3.

4. Set the stiffness of spring #3 to "hard".
5. Fill in the data table below.

Mass (g)	Mass (kg)	Force - weight (N) Hint: mass (kg) x gravity = weight	Distance spring stretched (cm)
50	0.050	0.050 x 10 = 0.5	
100			
250			

6. Using Hooke's Law calculate the elasticity of spring #3 now.

7. Using spring #3 and Hooke's Law, calculate the weight (g) of the brown barrel.
Remember: force (weight) = elasticity x distance stretched

8. Would you expect spring #3 to stretch more or less on the moon? Why? Try it out and see!